Fostering Collaboration In a Competitive Workplace: A Game Theoretic Approach

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1. INTRODUCTION

1.1 Competitive Workplace Environments: Competition and Collaboration

In today's competitive work environments, both competition and collaboration often exist simultaneously, as recognized by Katherine Milkman et al. (2014). In order for firms to accomplish organizational objectives, employees need to collaborate in teams and projects. At the same time, however, employees are equally concerned with their individual self-interests, as suggested by homo economicus rationality. When employees' individual self-interests become misaligned with the payoffs of organizational collaboration, employees can be rationally expected to not collaborate with one another, as indicated by Marshall Goldsmith (2008). If such failure to engage in teamwork becomes widespread and systemic, an organizational breakdown could occur, thereby resulting in the downfall of the entire organization.

1.2 General Purpose and Goals

The purpose of this paper is to use game theoretic methods to study the conditions necessary to foster, and sustain, collaboration among employees in a company. The challenge is to structure an organizational setting that promotes effective collaboration while satisfying the personal competitive nature of employees within the workplace. Corporate managers will be able to leverage these strategies to manage their employees, and more effectively achieve business objectives.

2. LITERATURE REVIEW

2.1 Research on Competitive Workplace Environments

The modern workplace is as competitive as it has ever been. With increasing automation, globalization, and industry maturation, companies and employees face growing competition from all sides.

As companies grow, and seek continued development, employees have to work together on assignments, projects, and teams. Collaboration is critical to the success of modern organizations. In almost every sector of the economy, vital work is accomplished through collaboration (Edmondson and Nembhard, 2009). In fact, more than 50% of employees at organizations in the U.S. report spending a portion of their workday in collaborative groups (Steward, Manz, and Sims, 1999). As Wal-Mart CEO and founder Sam Walton explained, "individuals don't win in business, teams do. We're all working together, and that's the secret" (Carpenter and Coyle, 2011).

However, as companies compete externally, so do their employees internally. Employees compete with one another for assignments, recognition, raises, and promotions (Kilduff, Elfenbein and Staw, 2010). Since internal corporate resources are not infinite, not everyone will get what they want. As Tomas Chamorro-Premuzic (2014) points out, "all organizations are political – and to some degree, they always will be". This is because work involves dealing with people. That means finding a compromise between what they want and what we want" (Chamorro-Premuzic, 2014).

While it appears that academia widely recognizes the existence of internal politics within organizations (Goldsmith, 2008), there seems to be a dearth of game theoretic strategies that leverage these concepts for workforce management. This paper seeks to address the topic of how to promote internal collaboration among employees, even as they seek to maximize their own self interests. This is explored in the spirit of promoting effective human resources management to drive company performance.

2.2 Research on Game Theory and the Prisoner's Dilemma

Game theory is the study of interdependent decision-making (Robert Neugenboren, 2016). It applies to almost all social situations where parties can be expected to be rational 'players' seeking to maximize their self-interests. A game of particular significance within game theory is the "prisoner's dilemma" game, in which economists investigate how cooperative behavior may emerge in a

population of rational egoists (Neugenboren, 2016). The game was originally framed by Merrill Flood and Melvin Dresher in 1950, and subsequently by Albert Tucker (Poundstone, 1992). The dilemma of the game lies in that in a one-round prisoner's dilemma game, the equilibrium strategy of both players is not "Pareto-optimal". Both players are invariably incentivized to "defect" (i.e. not help each other), despite the fact both would achieve a better result had they cooperated (Poundstone, 1992).

Many studies on the prisoner's dilemma game have since been conducted, in order to determine whether there are optimal strategies that enhance the collective outcome of such a game. One of the most renowned studies was conducted by Robert Axelrod (1984) who held a tournament to pit various strategies against one another. A group of scholars were invited to submit strategies for this tournament, which consisted of indefinitely repeated prisoner's dilemmas. Sixty strategies were submitted, but the ultimate winner was a very simple one – the Tit for Tat strategy. The Tit for Tat strategy behaved as follows: "cooperate on the first move, and then do whatever its opponent did in the previous move" (Axelrod, 1984). Tit for Tat's success as a strategy presents numerous lessons for dealing with real world situations that mimic prisoner's dilemmas.

The four key drivers of Tit for Tat's success in the repeated prisoner's dilemma game were as follows (Axelrod, 1984):

1. Nice: Cooperates by default, prevents it from getting into unnecessary trouble
2. Retaliatory: Discourages the opponent from persistently defecting
3. Forgiving: Helps restore mutual cooperation
4. Clear: Exhibits clear, predictable logic that is visible to the opponent

However, subsequent research reveal that the Tit for Tat strategy exhibits certain weaknesses, as documented by Jianzhong Wu and Robert Axelrod in 1994. The strategy's primary weakness is the inability to cope with noise in the repeated prisoner's dilemma. Noise is defined as the occurrence of random errors in implementing a choice, and is a common problem in real world interactions (Wu and Axelrod, 1994).

According to Wu and Axelrod, there are three approaches to coping with noise:

1. Adding generosity to a reciprocating strategy;
2. Adding contrition to a reciprocating strategy; and
3. Using an entirely different strategy, Pavlov (based on the idea of switching choice whenever the previous payoff was low)

Wu and Axelrod conducted a re-trial of the famed 1980 repeated prisoner's dilemma tournament, but this time with a 1% noise level. The result was that a strategy called the "Contrite Tit for Tat" (or "CTFT") won. Note that in this environment, both the "generous" version of Tit for Tat ("GTFT") and the Pavlov strategies did not prevail. The tournament lasted for 2000 generations (i.e. matches).

More recently, a 100,000-generation repeated prisoner's dilemma tournament was conducted in a game theory course taught by Robert Neugeboren (2016) at Harvard University. In this tournament (also with 1% noise), one of the three surviving strategies (out of 25 initially submitted strategies) was also a Contrite Tit for Tat strategy (called the "X3" strategy).

The Contrite Tit for Tat strategy has three states: "content", "provoked", and "Contrite", described by Axelrod and Wu (1994) as follows:

- Content State: It begins in content with cooperation and stays there unless there is a unilateral defection.
- Provoked State: If it was the victim (i.e. opponent defected, while it cooperated) while content, it becomes provoked and defects until a cooperation from other player causes it to become content.
- Contrite State: If it was the defector while content, it becomes Contrite and cooperates. When Contrite, it becomes content only after it has successfully cooperated.

3. GAME MODEL

In this section, I propose a game model that mimics the real-life situations that employees face when working with others in a competitive workplace. The game is characteristic of an iterated prisoner's dilemma, in which the players are two individual colleagues, and they can either "cooperate" or "defect" when working together as a team. In alignment with traditional prisoner's dilemma payoffs, the collective benefit of cooperating while working together is much higher than that of mutual defection. In every round, the payoff is always detrimental to the person who unilaterally cooperates when the other defects.

3.1 Key Definitions and Assumptions

Players: the players are assumed to be two individual colleagues (who can be at any level) in a company. They are both rational, and interested in maximizing their utility scores. They two player work together in a team or in a project. If they both collaborate, the team will yield strong results; payoffs for both players will be high. If they both choose to not collaborate, the team will fail and yield poor results; payoffs for both players will be low. If only one chooses to defect while the other collaborates, the defector receives the temptation payoff which is higher than what he would have attained had they both collaborated.

Payoffs: payoffs for this game are measured with utility scores.

Utility scores: in this game, utility scores are measured by the amount of *personal credit and recognition* that the employee receives for himself/herself. It is assumed that all employees want to maximize their personal credit because this helps build a personal brand and a strong reputation (Kilduff, Elfenbein and Staw, 2010). A strong personal brand and reputation in turn leads to promotions, raises, and opportunities (Harvard Business Review, 2015). This game assumes that employees' individual utilities are directly linked to the amount of personal credit and recognition that he/she receives because he/she is a rational, competitive person who wants to be promoted and receive raises to the maximum extent possible.

For example, a score of 5 is better than a score of 1, with '5' meaning that the employee received maximum personal credit and recognition within the firm, and '1' meaning that the employee received minimum personal credit and recognition.

Cooperate ("C"): in the context of this game, to "cooperate" represents a set of cooperative behaviors (not a single simple action). To "cooperate" means that the employee engages in the following behaviors in support of collaboration:

- Helping the other colleague
- Sharing pertinent information
- Seeking to promote the success of joint projects
- Sharing credit when due

Defect ("D"): in the context of this game, to "defect" represents a set of non-cooperative behaviors (not a single simple action). To "defect" means that the employee engages in the following behaviors to not cooperate with the other player:

- Framing the other colleague
- Hoarding information
- Not seeking to promote the success of joint projects
- Taking undue credit

Repeated indefinite prisoner's dilemma: this game is designed to be a repeated prisoner's dilemma in that it is "played" indefinitely. Its players do not know how many rounds will be played, or when it will stop. Since the game represents collaboration, this is a reasonable assumption because in reality, employees cannot predict when they will leave a company or project, when a company will go bankrupt, or when a colleague will leave the company or project.

3.2 Proposed Game Model and Strategy

The proposed game model is a repeated indefinite-round prisoner's dilemma. In line with a conventional prisoner's dilemma game, the payoffs are defined below:

Prisoner's Dilemma

Employee 1 \ Employee 2	C	D
C	3,3	0,5
D	5,0	1,1

Figure 1: joint payoffs are higher when employees cooperate with each other

If both players work together, they will achieve the payoff of (3,3), which is higher than the payoff of (1,1) when they receive when they both defect. This is because when both players work together, the team (or project) becomes much more successful. However, in order for mutual collaboration to occur, both parties need to have assurance that the other is going to cooperate rather than defect.

If this game was played for only a single round, the equilibrium strategy would be for both players to "defect", thereby producing a payoff of (1,1). In the context of this example, it means that both players will chose to not work together collaboratively because both know that the other will not be pulling their weight. Consequently, the team produces poor results.

If this game were to be played repeatedly and indefinitely, then more sophisticated strategies can be employed. In referencing existing research on noisy iterative prisoner's dilemmas, Wu and Axelrod (1994) described one optimal strategy to be the "Contrite Tit for Tat" (see figure 2). This strategy is both generous and conditionally reciprocating. This modified version of the Tit for Tat strategy has been proven to be superior to the original one because of its ability to cope with noise in these games.

When depicted as a finite automaton, the Contrite Tit for Tat strategy is shown as follows:

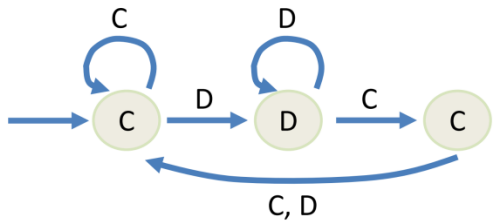

Figure 2: The Contrite Tit for Tat strategy, a successful strategy in a repeated prisoner's dilemma with 1% noise

As succinctly pointed out by Wu and Axelrod (1994), the competitive advantage of the Contrite Tit for Tat strategy lies in that it is both generous and conditionally reciprocating. It is forgiving and does not perpetually retaliate under noisy conditions. This allows for the opponent's occasional uncooperative behavior to be forgiven and forgotten, as long as it was not permanently intentional.

What it means in the context of this real-life example is that when an employee works with others, he/she should always start off by collaborating. This implies helping the other colleague, sharing pertinent information, seeking to promote the success of joint projects, and sharing credit when due.

The other employee (who is also on the team or project) would benefit by doing the same because when both employees cooperate, they achieve the highest joint payoff.

Of course, there is always the temptation for one employee to defect while his counterpart was cooperating. In this example, it could mean that one employee does all the work while the other one takes all the credit and rewards. Based on the Contrite Tit for Tat strategy, if this happens once, the "victim" should immediately defect in the next round as well. However, this defection should only occur once, and regardless of what happens in the subsequent round, the Contrite Tit for Tat player should revert back to cooperating again. This disciplined approach (or philosophy) enables both players to restore cooperative relations over the long run, even if one player defected (either temporarily or accidentally).

3.3 Game Results

In a single-round prisoner's dilemma, the equilibrium strategy would be for both players to "defect", thereby producing a payoff of (1,1). This is of course, a suboptimal result because it is not Pareto-optimal, and both players can be better off had they collaborated. Therefore, it is more meaningful to examine how the game can be played when it is repeated for an indefinite number of rounds.

In an indefinitely repeated prisoner's dilemma game, a Contrite Tit for Tat strategy is likely a long-term survival strategy. This has been evidenced in both the Wu and Axelrod tournament of 1994, and the Neugeboren tournament of 2016, where 'Contrite Tit for Tat' consistently came in as a top three strategy. Note also that both tournaments had a 1% noise level. Therefore, in the absence of having the resources to conduct real-life experiments with the careers of employees over thousands of projects and team collaborations, the two above-mentioned tournaments are seen as proxies for what the ultimate result will be. It can be inferred that the Contrite Tit for Tat strategy is a sustainable strategy that will last and succeed over time.

4. ANALYSES AND DISCUSSIONS

4.1 Analyses and Implications of Results

The key implication of the result of the Wu and Axelrod tournament of 1994, and the Neugeboren tournament of 2016 is that the Contrite Tit for Tat strategy can be a highly successful long-term strategy in indefinitely repeated prisoner dilemma games (with noise). When applied to the competitive workplace where employees often need to work together, but are also competing against each other, the recommendation here is to also adopt the Contrite Tit for Tat strategy.

In reality, this means:

- Collaborate by default, and start off by collaborating. Help one's colleagues, share credit, share information, and be a contributor to the success of the team and project.
- If your colleague reciprocates with collaboration, continue collaborating. This is a mutually beneficial arrangement in which both will win.
- If your colleague, for any reason, does not reciprocate with collaboration, then stop exhibiting collaborative behaviors (i.e. "defect") in the next project/engagement. This will signal that you are provocable, and not to be taken advantage of. If the colleague continues to defect, then you defect until he switches to collaboration.
- Once the colleague resumes collaboration, start collaborating again (see figure 2). Practise "forgive and forget"; do not hold grudges (which is unproductive for both parties).
- Be nice by default, forgive occasional non-collaborative behaviors, but be provocable if the colleague is taking advantage of you.

Additional recommendations:

- Ascertain whether your colleague is "in it for the long haul" (i.e. he/she is going to be with the company or industry for the foreseeable future). Otherwise, you might think you are playing an indefinitely repeated prisoner's dilemma when in fact, you are playing a one-round prisoner's dilemma (in which case the colleague's interest-maximizing strategy is to defect by default).
- Beware of collaborating with someone who has certainty of leaving the organization in the foreseeable future. When one of the parties is leaving the company or team, it would be in his/her rational self-interest to simply "defect", because the game suddenly becomes an "n-round repeated prisoner's dilemma". Through backward deduction, the subgame-perfect Nash equilibrium suggests a "defect" strategy for these situations. This is when cooperating

does not reap its rewards. (This may explain why firms do not let people know when they will be let go; and when they do know, it is usually on the spot.)

- When dealing with an unmotivated or disengaged colleague, cooperating with him/her may not be in one's rational self-interest. This is because his/her utility function may not be correlated with the amount personal credit or recognition that he/she attains. He/she may have already given up, or is disgruntled, or only wants to coast along in his/her job. In this case, the payoffs of the game will change in such as way that it may no longer constitute a prisoner's dilemma, and the above-mentioned game strategies will not apply.
- From a corporate executive's perspective, teamwork and collaboration should be encouraged because the company is more efficient that way. In order to set the stage for this, an environment mimicking the indefinitely repeated prisoner's dilemma must be set up. Therefore, companies should ensure that employees are "in it for the long haul" (i.e. have consistent long term career goals), are highly motivated (i.e. seeking to optimize their payoffs), and care about their career progression (i.e. are rational).

4.2 Assumptions and Limitations

As with all theories, there are certain assumptions and limitations to this game theory and strategy.

The main assumptions and limitations that come with this game theoretic approach are as follows:

- The game is assumed to be a prisoner's dilemma. Therefore, before applying this framework to any real-life situation, ascertain that the payoffs do indeed satisfy the constraints of a prisoner's dilemma game (eg. combined payoff from mutual collaboration > combined payoff from single defection > combined payoff from mutual defection).
- The game is restricted to just two players. In real life, however, one often needs to work with more than just two people at once. Nevertheless, the strategies stated herein can still be relevant, because there are two ways to think about situations involving more than two people:
    - If possible, classify the collection of people into two distinct interest groups. Treat each interest group as a single "player" in the game. Each "move" that is made represents the interest group acting on behalf of its interests.

    - If you have to engage with more than 1 counterpart, engage with each of them individually (i.e. sequentially). For example, if you are dealing with A, B, and C: deal with A individually first, then with B, and then with C.
- The game is assumed to be played repeatedly for an indefinite number of rounds. This is an important condition, and therefore only applies to situations where the players will continue to encounter each other for the foreseeable future. The situation no longer holds when the players are temporary contractors, retiring professionals, or workers about to be laid off or switching jobs.
- Players are assumed to be rational, and their utility scores are assumed to have been accurately estimated. When designing strategies for this game, the utility scores were estimated, and assumed to be constant forever. This is a universal limitation that impacts the applicability of game theory to human beings
- Players are assumed to want to maximize their payoffs. In real life, some individuals do not actively maximize their utilities. This could be due to various psychological reasons such as altruism, vindictiveness, or sense of fairness.
- The game was assumed to have a 1% noise. Noise represents the percentage chance of a player's move randomly deviating from the intended strategy. Both the Wu and Axelrod (1994) and Neugeboren (2016) tournaments featured a 1% noise level. While this is certainly more realistic than a 0% noise level, there is little evidence to suggest that real-life situations involving humans also consistently feature a 1% noise level. Therefore, to the extent that additional noise does not distort the results of the strategies adopted, the Contrite Tit for Tat strategy holds.
- The Contrite Tit for Tat strategy was identified as the most optimal strategy for noisy iterated prisoner's dilemmas because of the results of two tournaments (Wu and Axelrod, 1994, and Neugeboren, 2016). However, there may be additional tournaments of a similar nature that present other strategies which perform as well, if not better than the Contrite Tit for Tat strategy. However, this paper mainly explores the Contrite Tit for Tat strategy given its demonstrable success to date.

5. CONCLUSIONS

Overall, when employees collaborate with one other in teams and joint projects, everyone benefits. People are happier, the company is more productive, and less resources are wasted. In reality, however, sustained collaboration depends much more on rational individual interests than it does on altruism. We can summarize the key findings of the paper as follows.

We first used the Prisoner's Dilemma game as a proxy for the working relationship between two colleagues within a competitive workplace. Some of the main conditions necessary for this to hold true include: Prison's Dilemma-like payoff structure, long-term (indefinite) working relationship, and an economically rationalist approach, etc.

We then examined ways to maximize the payoffs for both parties within such a construct. The recommended strategy here is Contrite Tit for Tat, a strategy that has turned out to achieve one of the best results (i.e. highest payoffs) in numerous game theory tournaments. In short, the Contrite Tit for Tat strategy is a strategy that starts out by co-operating, temporarily "punishes" a counterpart for not co-operating, and then returns to co-operation mode thereafter.

This paper also cautioned against the situations under which the strategy will not work, such as when the payoff structure is non-prison dilemma-like, when parties are engaged in short-term or finite-term interactions, or when parties are not economically rational (eg. overly emotional).

Given the above context, it is in the best interests of all organizational leaders to develop workplace policies and incentives that mimic the indefinitely-repeated prisoner's dilemma game (eg. implementing reputation-based feedback, long-term performance tracking, incentives for employee co-operation, disincentives for non-cooperation, etc.). Once such foundational structures are built, whereby the actual operating environment closely mimics the payoff structure and construct of a prisoner's dilemma game, then rational individuals within the organization will realize that co-operating with one another (as opposed to not co-operating) is their most rational behavioral choice in the long run. To deal with non-cooperating colleagues, they may then wish to use the Contrite Tit for Tat strategy recommended here (which has demonstrated strong results in many experiments).
Therefore, when this construct is applied on a system-level, everyone will be motivated to collaborate and cooperate, even if it is within the confines of a very internally-competitive firm.

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